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(71) Applicant
MTU Motoren- und Turbinen-Union München GmbH

(Incorporated in FR Germany)

Dachauer Strasse 665, Postfach 50 06 40, 8000 Munchen 50, Federal Republic of Germany

(72) Inventor
Jürgen Lemmin

(74) Agent and/or Address for Service
Haseltine Lake & Co,
Hazlitt House, 28 Southampton Buildings, Chancery Lane, London WC2A 1AT

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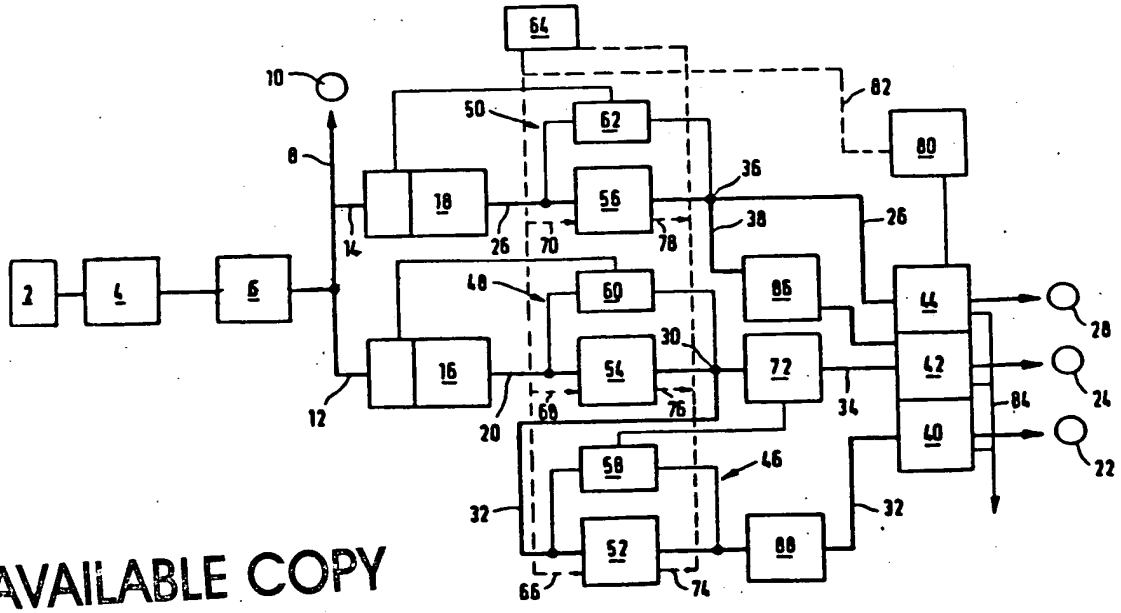
(57) The control apparatus allows individual modulation of the fuel flows to the ignition burner 22, to the main burner 24 in the internal flow and to the burner 28 in the by-pass flow of a gas turbine engine after-burner. The two fuel systems of the internal flow are controlled by metering valves 52, 54 and a throttle valve 72 so that they can be individually modulated without any reciprocal reactive effects. The fuel supply of the by-pass flow burner 28, controlled by a metering valve 56, is independent of the fuel supplies of the internal flow so that its modulation also has no reactive effects on the fuel supplies of the internal flow. The apparatus also makes possible the speedy pre-filling of the injection lines, with the injection lines of the ignition burner 22 being pre-filled via the metering device 48 for the entire amount of fuel to the internal flow, and the injection lines of the main burner 24 in the internal flow being pre-filled via the metering device 50 and a change over valve 86, for the fuel of the by-pass flow burner. A pump 16 supplies the fuel for the burners 22, 24 and a pump 18 supplies fuel for the burner 28. A control unit 64 controls the metering devices 46, 48, 50 (incorporating the valves 52, 54, 56 and pressure drop regulators 58, 60, 62). Check valves 40, 42, 44, a pressure build up valve 88, and a valve switching unit 80 are also provided. Fuel is supplied from an aircraft-side fuel system 2 via engine-side fuel system 4 and a fore pump 6. Fuel is also fed to the high pressure pump 10 in the fuel system of the engine.



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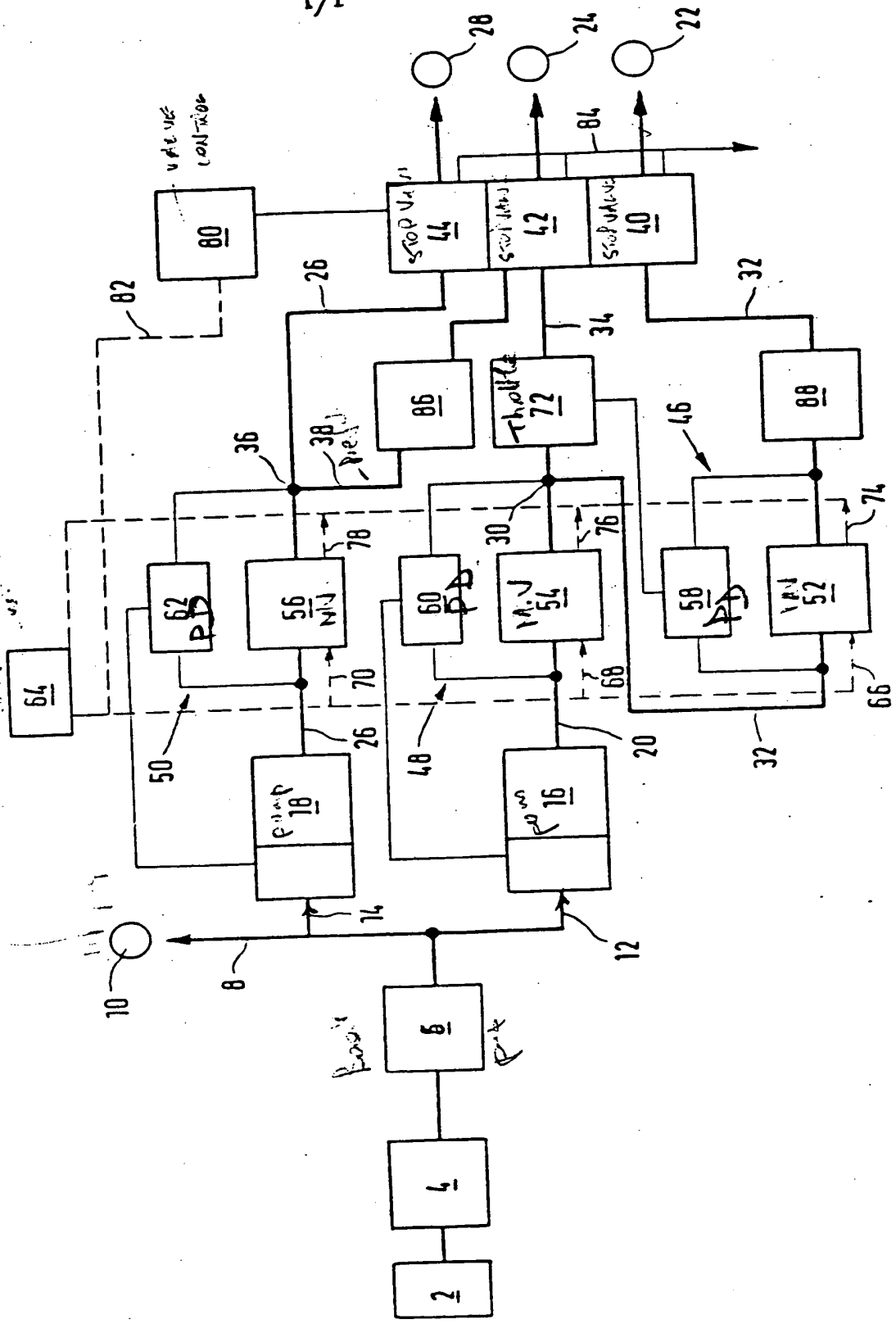
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SPECIFICATION

Apparatus for controlling the fuel supply to the after-burner of a by-pass flow gas-turbine jet engine

The invention relates to an apparatus for controlling the fuel supply to the after-burner of a by-pass flow gas-turbine jet engine, comprising a fuel-pump arrangement and connected to this a fuel line connectable to the burners of the internal flow, which is divided respectively into a fuel line for the main burner of the internal flow and one for the ignition burner of the internal flow, and a fuel line for the burner of the by-pass flow, wherein in the fuel lines for the main and ignition burners of the internal flow, and for the burner of the by-pass flow there is respectively arranged a controllable fuel metering device.

In by-pass flow jet engines, after-burning presents special problems because two air flows with considerably different temperatures have to be after-burned. Amongst earlier processes, in which the hot air of the internal flow and the colder air of the by-pass flow were first of all mixed and the fuel was injected into the mixed air by means of a burner system arranged at the end of the mixing section, it is also already known to supply fuel separately to the internal flow and to the by-pass flow respectively by means of separate burners. Hence with respect to the earlier system an improvement in the after-burning efficiency and a reduction in the engine weight and the engine length could be achieved.

There is already known a device of the type referred to above in which the after-burner fuel is conveyed from a pump into a fuel line to the burners of the internal flow and into a fuel line to the burners of the by-pass flow, whereby from the first fuel line there branches off a fuel line to the ignition burners (see "Afterburning Regulation Concepts", in particular page 16.10 and 16.11 and Fig.6-3; K. Robinson, Dowty Fuel Systems Ltd., AGARD PAPER NO.....). In all three fuel lines metering devices are arranged through which respectively different amounts of fuel are metered to the ignition burners, to the main burners of the internal flow and to the burners of the by-pass flow. The metering devices are synchronously adjusted by a regulating device so that after-burner thrust modulation is also possible. Because of the synchronous adjustment of all the metering devices, the after-burner can be optimally designed, but basically only for a specific operating level, for example for maximum thrust; in the case of all other operating levels, for example with a partial load operation of the after-burner, which is required more and more nowadays also as an operational possibility, the degree of efficiency decreases sharply. A definite improvement in the degree of efficiency during partial load operation was achieved firstly by parts of the burners being switched off and the remaining fuel thus being able to be better prepared, and on the other hand by the fact that by the introduction of additional metering parameters the fuel metering during after-burner partial load was improved.

With the known device, when the after-burner is switched-on, the injection lines of all the burners must already be pre-filled, and even in the case of the respectively non-active burners they have to be kept pre-filled; since during pre-filling respectively large amounts of fuel have to be conveyed in a short time, pre-filling of burner systems which have to be switched-on again would not be possible without a harmful effect on the already active burners, because of the sudden drop in pressure in the fuel lines. For this reason the injection lines also of individual burners to be switched-off can only be blown-off when the entire after-burner is to be switched-off. This leads to a poor degree of combustion in the after-burner partial load operation. A further disadvantage of the known device is due to the fact that pre-filling of the injection lines of all the burner systems has to take place simultaneously before ignition of the after-burner, which consequently means a comparatively long reaction time, which is the time between the pilot's switching-on the after-burner up to ignition.

According to the present invention, there is provided apparatus for controlling the fuel supply to the after-burner of a by-pass flow jet turbine engine, comprising a fuel-pump arrangement and connected to this a common fuel line connectable to the burners of the internal flow, which is divided respectively into a fuel line for the main burner of the internal flow and one for the ignition burner of the internal flow, and a fuel line for the burner of the by-pass flow, wherein in the fuel lines for the main and ignition burners of the internal flow and for the burner of the by-pass flow there is respectively arranged a controllable fuel metering device, the fuel-pump arrangement including a first fuel pump for supplying the common fuel line of the burners of the internal flow and a second fuel pump for supplying the fuel line of the burner of the by-pass flow, the capacity of which can be regulated independently of each other, and in which in the fuel line to the main burner of the internal flow there is arranged a throttle valve which can be controlled by the fuel metering device in the fuel line of the ignition burner, there being further provided leading from the fuel line for the burner of the by-pass flow, a preliminary filling line opening into the fuel line of the main burner of the internal flow, in which preliminary filling line there is arranged a preliminary filling change-over valve for the selective connection of the preliminary filling line to the fuel line of the

burner of the by-pass flow.

In certain embodiments, the invention makes possible optimisation of the efficiency of the after-burner at after-burner operating levels between maximum and minimum after-burning, which has good combustion efficiency in the after-burner partial load operation, and which has short reaction times, the apparatus also having low assembly costs.

It can be seen that optimisation of the after-burner efficiency is possible with any after-burner operating level between maximum and minimum after-burning, if the individual burner systems can be controlled individually, i.e. completely independently of each other. One can certainly assume that during switching-on of the after-burner and acceleration up to full load, one after the other, first of all the ignition burner is switched-on, then the main burner in the internal flow and finally the burner in the by-pass flow. The terms main burner, burner in the after-burner, and ignition burner are intended to mean respectively several individual burners with the same function which are divided in suitable form over the cross-sectional surface of the after-burner inlet. To achieve good degrees of combustion and short reaction times pre-filling of the injection lines of individual burner systems should take place only when these are to be switched-on, whereby reactions on the respectively already active burner systems, for example a short term reduction in the fuel sypply to this system, are not permitted. The switching-off of the after-burner occurs in reverse sequence, i.e. first of all the burner in the by-pass flow is switched-off, then the main burner in the internal flow, and finally the ignition burner. During the after-burner operation, the individual, respectively active burner systems should be able to be modulated independently of each other according to their own metering parameters, which also includes, for example, the possibility of increasing the fuel influx to one or two burner systems and at the same time reducing the fuel influx to the one or more than one remaining burner systems. With specific operational areas of the after-burner an optimal degree of efficiency is achieved when either the ignition burner alone is operated, or the latter together with the main burner in the internal flow, so that these methods of operation should also be possible.

It has been shown that completely separate conveying- and regulating-systems for each individual burner system generally have to be excluded because of the great structural weight and the great amount of assembly space required. According to the present invention two fuel pumps are used, the first of which supplies the fuel line to the burners of the internal flow, to which the ignition burners also belong, whilst the second fuel pump feeds the fuel line to the burner of the by-pass flow. The two fuel pumps are so connected from the point of view of switching and regulation that the requirements set out at the beginning are fulfilled. In addition in the fuel line to the main burner of the internal flow there is arranged a controllable throttle valve which controls the partial flow branching off to the ignition burner, so that there is no need for a separate fuel pump for the ignition burner. The amount of fuel supplied to the main burner in the internal flow arises from the difference between the total amount supplied by the first fuel pump and the amount of fuel branching off to the ignition burner, so that the main burner in the internal flow can be substantially regulated by a change in the amount delivered by the first fuel pump. The fuel delivery system for the burner in the by-pass flow is substantially independent of that of the two other burner systems, so that modulation can be effected for this without any reactive effects.

Pre-filling of the injection lines of the ignition-burners takes place through the first fuel pump, whilst the injection lines to the main burner in the internal flow are still switched off. Since the first fuel pump is designed for supplying both burners of the internal flow, the pre-filling time and hence the reaction time of the after-burner up to the first ignition is very short. The injection lines of the main burner in the internal flow can be pre-filled substantially simultaneously by the second fuel pump via the pre-filling line and the pre-filling reversing valve, while the injection lines to the burner of the by-pass flow are still closed, so that this pre-filling process also takes place in a very short time and has no reactive effect on the metering of the fuel flow to the ignition burner. After pre-filling of the injection lines to the main burner in the internal flow, the pre-filling change-over valve is closed so that the entire fuel flow delivered by the first fuel pump is available for filling the injection lines for the burner of the by-pass flow, so that these also can be pre-filled in a very short time.

Control of the fuel metering devices may take place, according to a preferred embodiment of the invention, by means of an electronic control unit in accordance with fixed metering parameters. Even the control of the fuel supply in general can be effected by means of the electronic control unit.

According to an embodiment of the invention the fuel metering devices are constructed as metering valves, the throughflow cross-section of which is predetermined by the control unit and the pressure drop of which is regulated by respectively associated pressure drop regulators; the pressure drop regulator of the metering valve arranged in the collecting line to the burners of the internal flow thus regulates the capacity of the first fuel pump, the pressure drop regulator of the metering valve for the ignition burner adjusts the throttle

valve, the pressure drop regulator of the metering valve for the burner of the by-pass flow regulates the feed performance of the second fuel pump.

In a further embodiment of the invention provision is made in the fuel lines to the main burner of the internal flow, to the ignition burner and to the burner of the by-pass flow, for the arrangement, respectively in front of these burners, of check valves which can be individually controlled by means of the electronic control unit. These allow the individual burner systems to be individually switched-on or off according to the presetting of the control unit. Hence in a further embodiment of the invention there can be respectively associated with each check valve, a blow-off valve, through which the fuel lines downstream of a respective check valve can be connected to a blow-off device after closure of the check valves. The blowing-off of the injection lines of the respectively not required burner systems contributes substantially to the improvement in the combustion degree with partial load operation, whereby at any time when required a repeated pre-filling of these injection lines is possible in the way described above.

If the burner systems are respectively switched-on or off as a whole, the check valves can be designed according to the invention as open/close valves. On the other hand, if individual burner systems, for example the main burner in the internal flow and/or the burner in the by-pass flow, comprise individual groups of nozzles which can be switched-on or off one after the other, then appropriately constructed sequence valves are used as check valves.

In a further embodiment of the invention provision is made for the arrangement of a pressure-build up valve downstream of the metering valve in the fuel line to the ignition burner. The purpose of this is to maintain a specific fuel pressure even with a low fuel throughflow, so as to be able to carry out, for example by the fuel itself, specific servo operations.

An embodiment of the invention is shown in the drawing and described in detail below.

The figure shows a block diagram of a device for controlling the fuel supply to the afterburner of a by-pass flow jet engine with three separate burner systems.

From the aircraft-side fuel system 2, fuel is fed to the engine-side fuel system 4. From there it is brought, by means of a forepump 6, to a pressure level which ensures a cavity-free operation of the subordinate high pressure pumps for the basic engine and for the after-burner. From the forepump 6 the fuel is fed via a fuel line 8 to the high pressure pump 10 in the fuel system of the basic engine. The equipment described up to here is known and is not a subject of the present invention.

From the forepump 6 fuel is additionally fed via fuel lines 12,14 to the two high pressure fuel pumps 16,18 in the fuel system of the after-burner.

The first fuel pump 16 supplies a fuel line 20 which leads to the burners arranged in the internal flow of the jet engine, viz. to the ignition burner 22 and to the main burner 24 in the internal flow. The second fuel pump 18 supplies a fuel line 26 which leads to the burner 28 in the by-pass flow.

The fuel line 20 divides at the point 30 into a fuel line 32 to the ignition burner 22 and into a fuel line 34 to the main burner 24 in the internal flow. From the fuel line 26 to the burner 28 in the by-pass flow there branches off, at the point 36, a pre-filling line 38 which opens into the fuel line 34. It is used for pre-filling the fuel line 34 or the injection lines of the main burner 24 connected to this.

In the fuel lines 32,34 and 26 there are respectively arranged check valves 40,42 and 44 which are used to block these fuel lines when the associated burner systems are shut down. As the Figure shows, the junction of the pre-filling line 38 to the fuel line 34 can be integrated in the check valve 42.

In the fuel lines 32, 34 and 26 there are respectively arranged fuel metering devices 46, 48 and 50 which respectively control the fuel influx to the ignition burner 22, to the main burner 24 in the internal flow and to the burner 28 in the by-pass flow. The fuel metering devices 46, 48 and 50 are substantially of the same construction and respectively incorporate a metering valve 52, 54, 56 and a pressure drop regulator 58, 60, 62 associated with the metering valve. The metering valves 52, 54, 56 are controlled via associated signal lines 66, 68, 70 from the electronic control unit 64 in accordance with predetermined metering principles. The metering cross-section of the metering valves is adjusted by the desired values fed into these signal lines; the drop in pressure in the metering valve is monitored by the pressure drop regulator and, by variation of the amount of fuel fed to the metering valve, is kept at a specific, predetermined value.

The drop in pressure in the fuel metering device 46 is controlled by adjusting a throttle valve 72, arranged in the fuel line 34 behind the branch-off point 30, the valve being connected to the pressure drop regulator 58, as is described in detail further back. The drop in pressure in the fuel metering device 48 is controlled by changing the capacity of the fuel pump 16 which is connected to the pressure drop regulator 60. The drop in pressure in the fuel metering device 50 is controlled by changing the feed performance of the fuel pump 18 which is connected to the pressure drop regulator 62. The positions of the metering valves 52, 54, 56 are reported back to the control unit 64 respectively via signal lines 74, 76, 78. The stop valves 40, 42, 44 are

actuated by an electro-mechanical valve switching unit 80 which is controlled by means of a signal line 82 from the control unit 64. Blow-off on drain valves can be integrated with the check valves 40, 42, 44 and these valves are also controlled by the valve switching unit 80 and make blowing-off or draining of the injection lines of the different burner systems possible by means of the blow-off line 84.

Arranged in the pre-filling line 38 there is a pre-filling change-over valve 86, by means of which the pre-filling line 38 can be opened or closed.

In the fuel line 32 there is arranged a pressure build-up valve 88 which ensures that there is an adequate fuel pressure even when there is a low fuel flow through the fuel line 32, this being essential for carrying out servo operations by the fuel.

The method of operation of the device is as follows:

If one proceeds first of all from stationary operation with minimal after-burning, then the stop valve 40 is opened, the stop valve 42 and the stop valve 44 are closed.

Both the metering valve 52 and the metering valve 54 are controlled by the electronic control unit 64 via the lines 66 or 68. The pressure drop regulator 60 keeps the pressure drop constant by means of the metering valve 54 in that it varies the amount delivered by the fuel pump 16. If fuel is to be fed only to the ignition burner 22, then the throttle valve 72 is kept in its closed position by the pressure drop regulator 58. In this operational state the metering valve 54 controls the flow of fuel in the fuel line 32.

If switching-on of the main burner 24 is required to increase the after-burner thrust, then first of all the check valve 42 is opened. The total fuel flow required for the ignition burner 22 and the main burner 24 is metered through the metering valve 54 in dependence on a desired signal predetermined by the signal lines 68 from the control unit 64; the portion branching off from there to the ignition burner 22 is metered through the metering valve 52 in dependence on the desired signal predetermined via the signal line 66.

The pressure drop regulator 60 keeps the pressure drop constant via the metering valve 54, in that it varies the amount delivered by the fuel pump 16.

The pressure drop regulator 58 keeps the pressure drop constant by means of the metering valve 52 in that it controls the adjustment of the throttle valve 72. As a result of this there is a change in the pressure in the line between the throttle valve (72) and the metering valve (54), which is corrected via the pressure drop regulator (60) by a corresponding correction in the capacity of the pump (16). The amount of fuel fed to the main burner 24 via the fuel line 34 once again is produced as a function of the position of the metering valve 54 and the controlled pressure drop.

If, for example, the fuel flow to the ignition burner is to be increased, then first of all the metering cross-section in the metering valve 52 is increased; the pressure drop regulator 58 compensates the resulting drop in pressure by a reduction in the throttle cross-section in the throttle valve 72. The position of the metering valve 54 for the total fuel to the internal flow remains unchanged.

The reduction in the throttle cross-section of valve 72 consequently leads to a reduction in the pressure drop via the metering valve (54) which is levelled by the pressure drop regulator (60) by the capacity of the pump (16) being increased. Hence the metered fuel to the main burner (24) is kept constant irrespective of a modulation in the fuel to the ignition burner.

In order now to increase the amount of fuel to the main burner 24, without thus changing the amount of fuel to the ignition burner 22, first of all the metering cross-section of the metering valve 54 is increased and the thus resultant reduced drop in pressure is compensated by means of the pressure drop regulator 60 by increasing the amount delivered by the fuel pump 16. The result of this again is first of all an increase in the drop in pressure through the metering valve 52. This is corrected by the fact that the pressure drop regulator 58 changes the position of the throttle valve 72 until the drop in presusure via the metering valve 52 again has the correct value.

In this way, therefore, both an opposite-direction change in the fuel flows to the burners 22 and 24 and also a same-direction change is possible, with the same or different rates of change, with the total fuel flow being respectively adjusted by the metering valve 54, and the desired distribution to the fuel lines 32 and 34 being regulated by the metering valve 52.

Regulation of the fuel flow to the burner 28 in the by-pass flow is completely independent of the metering of the fuel to the internal flow. If the metering cross-section of the metering valve 56 is changed in dependence on a desired signal fed-in via the signal lines 70, then the resultant change in the drop in pressure is respectively compensated through the metering valve 56 by a change in the amount delivered by the fuel pump 18.

Switching-on the after-burner and accelerating up to full load is always carried out so that first of all the ignition burner 22 is switched-on, then the main burner 24 in the internal flow and finally the burner 28 in the by-pass flow. Before the burner systems are switched-on, the associated injection lines have to be pre-filled as quickly as possible. Then in the shortest possible time the metering cross-section, predetermined by the elec-

tronic regulator because of the operating level pre-selected by the pilot, has to be adjusted in the metering valves.

In the initial state, operation of the basic engine is without any after-burning. If the pilot now selects the after-burner, then first of all, in accordance with a desired signal fed-in via the signal lines 68, the metering valve 54 is fully opened; parallel to this, in accordance with a desired signal fed-in via the signal lines 66, the metering valve 52 is adjusted to the pre-filling position which opens a valve cross-section which lies outside the normal modulation area of the metering valve 52 and is only used for pre-filling. In addition the stop valve 40 is opened and, if provided, the optionally integrated blow-off valve is closed.

When the metering valve 54 is opened, the fuel pump 16 is brought into the after-burner operating state. The pressure drop regulator 60 causes the fuel pump 16 to be moved to high capacity and hence the desired pre-filling of the injection system of the ignition burner 22 is carried out. After a time predetermined in the control unit 64, the metering valves 52 and 54 are so adjusted that the required fuel is metered to the ignition burner 22. Hence in accordance with the reduction in the metering cross-section in the metering valve 54, the amount delivered by the fuel pump 16 is so regulated by the pressure drop regulator 60 that the desired drop in pressure is adjusted via the metering valve 54. The metering valve 52 is also positioned in such a way that the fuel required for the ignition burner 22 is metered. As long as fuel is only fed to the ignition burner 22, the throttle valve 72 is moved by means of the pressure drop regulator 58 into the closed position and kept there.

In order to switch-on the main burner 24 in the internal flow, the metering valve 56 is set at pre-filling position and hence the fuel pump 18 is brought into operative state. The check valve 42 for the fuel to the main burner 24 in the internal flow is opened and, if there is one, the blow-off valve optionally integrated with it is closed.

The pre-filling, change-over valve 86 is opened so that the injection lines to the main burner 24 in the internal flow can be pre-filled with the full capacity of the fuel pump 18 by means of the metering device 50 for the fuel of the by-pass flow.

If the burner 28 in the by-pass flow is to be activated not directly following, when the pre-filling time has expired the metering valve 56 is closed and hence the fuel pump 18 is moved back by means of the pressure drop regulator 62. Thus the pre-filling change-over valve 86 closes automatically. By positioning the metering valve 54 and the throttle valve 72 in dependence on the pre-setting of the control unit 64, the required fuel is metered to the ignition burner 22 and to the main burner 24 in the internal flow.

If the burner system in the by-pass flow is to be switched-on then first of all the metering valve 56 is brought into the pre-filling position and the fuel pump 18 is made ready for operation and accelerated to pre-filling capacity by means of the pressure drop regulator 62. At the same time the check valve 44 is opened and, if there is one, the optionally integrated blow-off valve is closed. When the pre-filling time has expired, the metering valve 56 is brought into operational position in dependence on the desired signal predetermined by the signal line 70 and, by means of the pressure drop regulator 62, the amount delivered by the fuel pump 18 is so adjusted that the drop in pressure reaches its desired value through the metering valve 56.

The above-described switching-on procedures of the three metering systems are carried out in overlapping manner if, from normal operation of the basic engine, the pilot immediately pre-selects maximum after-burning. The procedure controlled by the electronic control unit is then as follows:

The pre-filling procedures for the injection lines of the ignition burner 22 and of the main burner 24 take place directly after each other or in overlapping manner. The pre-filling procedures for the injection lines of the burner 28 follow on directly, with the metering valve 56 and the fuel pump 18 being held at pre-filling position or pre-filling capacity after pre-filling of the injection lines for the main burner 24, and the pre-filling change-over valve 86 is automatically closed when the check valve 44 is opened or because of a corresponding signal from the control unit 64. In this way the time from when the pilot switches-on the after-burner up to ignition, and the time up to acceleration of the afterburner to maximum after-burning, can be carried out in a very short time.

From the concept of the entire system it would be possible to produce any switching-off sequence of the three burner systems by means of the electronic control unit 64. However, it can be shown that from the point of view of optimum after-burner efficiency the switching-off sequence should proceed in reverse order to the switching-on sequence, as has already been described above. Thus the individual steps of the switching-off sequence certainly do not have to proceed directly after one another, but for example, when the burner 28 in the by-pass flow has been switched-off, an after-burner operation can be maintained with fuel flows, modulated in any manner at all, to the two burner systems of the internal flow; also, when the main burner 24 in the internal flow has been switched-off, an after-burner operation can be carried out with the ignition burner alone.

Switching-off the fuel to the burners 28 is effected by closure of the metering valve 56 and the resultant reversal of the fuel pump 18

into a configuration corresponding to the switched-off state of the burner 28. At the same time the check valve 44 is closed by the control unit 24 by means of the valve switching unit 80 and if required the optionally integrated blow-off valve is opened.

To switch-off the main burner 24 in the internal flow, the metering valves 54 and 42 are so adjusted by means of the control unit 64 that the fuel still required for operation of the ignition burner is metered. At the same time the check valve 42 is closed and if required the optionally integrated blow-off valve is opened. As has already been described above, in this operational state the metering valve 54 takes over the metering of the fuel to the ignition burner 22. For switching-off the ignition burner the metering valves 52 and 54 are closed by means of the control unit 64, and the fuel pump 16 is adjusted into the configuration which corresponds to the switched-off burners 22 and 24. At the same time the check valve 40 is also closed and if required the blow-off valve optionally integrated with this is opened.

It is obvious that by the individual modulatability of the fuel flows to the different burner systems, in accordance with individual metering principles predetermined by the control unit, optimal after-burner efficiency can be achieved with any after-burner partial load- or after-burner full load-operating level of the engine. The metering principles stored in the electronic control unit 64 are to be defined and hence to be optimised for the respective engine, the respective after-burner and the required after-burner operational zone of an aircraft, so that optimal after-burner efficiency is achieved. These metering principles are not a subject of the present invention.

CLAIMS

1. Apparatus for controlling the fuel supply to the after-burner of a by-pass flow jet turbine engine, comprising a fuel-pump arrangement and connected to this a common fuel line connectable to the burners of the internal flow, which is divided respectively into a fuel line for the main burner of the internal flow and one for the ignition burner of the internal flow, and a fuel line for the burner of the by-pass flow, wherein in the fuel lines for the main and ignition burners of the internal flow and for the burner of the by-pass flow there is respectively arranged a controllable fuel metering device, the fuel-pump arrangement including a first fuel pump for supplying the common fuel line of the burners of the internal flow and a second fuel pump for supplying the fuel line of the burner of the by-pass flow, the capacity of which can be regulated independently of each other, and in which in the fuel line to the main burner of the internal flow there is arranged a throttle valve which can be controlled by the fuel metering device in the fuel line of the ignition burner, there being further provided leading from the fuel line for the burner of the by-pass flow, a preliminary filling line opening into the fuel line of the main burner of the internal flow, in which preliminary filling line there is arranged a preliminary filling change-over valve for the selective connection of the preliminary filling line to the fuel line of the burner of the by-pass flow.

2. Apparatus as claimed in claim 1, in which an electronic control unit is provided for the individual control of the fuel metering devices.

3. Apparatus as claimed in claim 2, in which the fuel metering devices are constructed as metering valves, the throughflow cross-section of each of which is controlled via respectively associated pressure drop regulators, wherein the pressure drop regulator of the metering valve in the common fuel line for the ignition and main burners of the internal flow controls the feed performance of the first fuel pump, the pressure drop regulator of the metering valve in the fuel line for the ignition burner controls the throughflow cross-section of the throttle valve in the fuel line for the main burner of the internal flow, and the pressure drop regulator of the metering valve in the fuel line for the burner of the by-pass flow controls the feed performance of the second fuel pump.

4. Apparatus as claimed in any one of claims 1 to 3, in which in the fuel lines for the main burner of the internal flow, for the ignition burner and for the burner of the by-pass flow, there are respectively arranged, upstream of the connection for the burners, check valves which can be individually controlled by the control unit.

5. Apparatus as claimed in claim 4, in which associated with the check valves there is provided a blow-off or drain valve through which the sections of the fuel lines leading to the burners and located downstream of the respective check valve can be individually drained after the check valves are closed.

6. Apparatus as claimed in claim 4 or claim 5, in which the check valves are constructed as open/close valves.

7. Apparatus as claimed in any one of claims 4 to 6, in which the check valve in the fuel line for the main burner of the internal flow and/or the check valve in the fuel line for the burner for the by-pass flow are constructed as sequence valves for the successive switching-on and off of individual groups of burner nozzles of the associated burners.

8. Apparatus as claimed in any one of claims 1 to 7, in which in the fuel line of the ignition burner there is arranged downstream of the metering valve a pressure build-up valve.

9. Apparatus as claimed in any one of claims 1 to 8, in which the preliminary filling change-over valve is actuated by hydraulic fluid in dependence on the internal system.

pressures, and in the closed position can be hydraulically locked.

10. Apparatus as claimed in claim 2 or any claim appendant to claim 2, in which the preliminary filling change-over valve is electrically controlled by the control unit.

11. Apparatus for controlling the fuel supply to the after-burner of a by-pass flow gas-turbine jet engine substantially as specifically described herein.

12. A gas-turbine jet engine having apparatus for controlling its fuel supply as claimed in any one of the preceding claims.

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